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EFFECTS OF GAMMA RADIATION IN TOMATO SEEDS

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ABSTRACT

Tomato dry seeds of the hybrid "Gladiador" F1 were exposed to low doses of gamma radiation from Co-60 source at 0,509 kGy tax rate in order to study stimulation effects of radiation on germination and plant growth. Eight treatments radiation doses were applied as follows: 0 (control); 2,5; 5,0; 7,5; 10,0; 12,5; 15,0; 20,0 Gy. Seed germination as well as green fruits number, harvested fruit number, fruit weight and total production were assessed to identify occurrence of stimulation. Tomato seeds and plants were handled as for usual tomato production in Brazil. Low doses of gamma radiation treatment in the seeds stimulate germination and substantially increase fruit number and total production up to 86% at 10 Gy dose. There are evidences that the use of low doses of gamma radiation can stimulate germination and plant production thus, showing hormetic effects.

Key words: Gamma radiation, hormesis, tomato.

1.INTRODUCTION

Tomato is one of the most labor and cost intensive horticultural crop in the World. It is also one of the most consumed vegetable. Its high volume consumed guarantees the importance as supplier of potash, folic acid, vitamins A, B1, B2, B3, C and E [1, 2].

Stimulation effects on germination, growth and production with the use of low doses of gamma radiation have been reported by many authors [3, 4, 5, 6, 7].

Degner and Schacht [8] comparatively studied the radiation effects after seed treatment with radiations (6.25 x 10-2 and 60 Gy) on germination process and on plant development of different maize varieties, wheat, barley, oat, lupine, colza and turnip to verify if the increases on final production could be observed and predicted during germination. It was, however, concluded that this foresight was not possible, because the stimulant dose production did not coincide with those that had stimulated germination.

The experiment presented here aimed to investigate the seed irradiation as a viable process to increase tomato germination and production in commercial tomato plantations.

2.MATERIALS AND METHODS

Tomato seeds, Hybrid "Gladiador" F1 of indeterminate growth, were treated in Co-60 source type “Gammacell”, with doses of 0 (control), 2,5; 5.0; 7.5; 10,0; 12,5; 15,0 and 20 Gy at dose rate of 0,509 $kGy.hour^{-1}$. A total of 100 seeds per treatment were planted 24 hours after treatment. Seed germination was assessed at 4, 8 and 7 days after sow. Non germinated seeds or malformed seedlings were considered as non germinated. Seedlings of 34 days old were transplanted to the field and handled as usual for commercial tomato production in Southeast Brazil. Green fruits with diameter higher than 3 cm number were assessed on 21/07 and 13/08. Fruit was harvested at beginning (14/08/09), middle (13/09/09) and end (11/10/09) of productive cycle. Fruit number, fruit weight and total production were based on 10 plants or replications per treatment. Tukey test was used in order to compare the means of parameters assessed.

3.RESULTS AND DISCUSSION

Table 1 shows total of seeds germinated on three different dates. It was observed a better germination rate in all the treatments seeds irradiated. The results are in accordance with those from other authors [4, 9, 10, 11] which related the germination stimulation through use of gamma radiation. Although the germination rate of hybrid "Gladiador" F^1 has not been a problem of major importance for seedlings producers, an increase in 1-4% germination is a big advantage in cost intensive crops as tomato. It does not only save the seed price but also the labor and other inputs involved on seedlings production.

Table 1. Total number of germinated seeds of 100 sowed seeds.

Treatment Gy	Assessment date			%
	08/04	10/04	13/04	
0	80	94	94	100,00
2,5	76	95	96	102,13
5	86	96	96	102,13
7,5	85	95	97	103,19
10	67	98	98	104,25
12,5	80	97	97	103,19
15	89	95	95	101,06
20	86	96	96	102,13

Results presented on Table 2, before initial harvest, indicated a significantly higher number of green tomatoes bigger than 3 cm for the treatments 12,5 and 15 Gy. A tendency of higher numbers of green tomatoes is also observed for all other treatments using radiation. Such results are similar to those achieved by Badr and collaborators [6]. It can be interpreted as an accelerated growth/ fruit development, due to use of low dose radiation.

Table 2. Average number of green fruits with diameter higher than 3 cm.

Treatment Gy	Number of fruits with diameter higher than 3cm	
	21/07	13/08
0	13,70 a	26,50 b
2,5	13,30 a	30,90 ab
5	10,60 a	28,20 ab
7,5	11,40 a	29,00 ab
10	13,60 a	33,20 ab
12,5	13,30 a	34,00 a
15	11,20 a	35,40 a
20	12,50 a	31,40 ab
F test	1,51 ns	3,35 **
DMS	4,37	7,37
C.V. %	25,18	17,01

Average values followed by same character in the column do not show difference as by Tukey test 5% probability. ns – not significant ($p \geq 0,10$); ‡ significant at 10% probability ($0,01 \leq p < 0,10$); *- significant at 5% probability ($0,01 \leq p < 0,05$); **- significant at 1% probability ($p < 0,01$).
LSD – Least Significant Diference

Table 3 indicated that excepting the treatment 7,5 Gy on the first event and treatments 12,5 and 15 Gy on the last event, all other treatments and events had their total fruit number increased.

Table 3. Total number of harvested fruits.

Treatment Gy	Total number of fruits per harvest event			Total number of fruits of all harvests
	14/08	13/09	11/10	
0	15	15	30	60
2,5	15	34	54	103
5	20	18	45	83
7,5	7	27	38	72
10	27	26	60	113
12,5	14	63	27	104
15	16	59	26	101
20	19	43	25	87

It is possible to observe in Table 4 that besides fruit number increase, there are also a fruit size increase in practically all treatments on the both first two events. Statistical significance is observed for treatments with higher doses as 12,5 to 20 Gy. Average fruit weight increased up to 111% for the treatment of 15 Gy. The results are contrary to those found by Badr and collaborators [6] which do not find and significant difference for the cultivar "Mecheast".

Tabela 4. Average fruit weight in grams.

Treatament Gy	Average fruit weight in grams			
	14/08	13/09	11/10	Average of all 3 events
0	113,74 ab	56,35 b	89,44 a	86,51
2,5	99,82 ab	87,48 ab	85,60 a	90,97
5	106,16 ab	78,21 ab	81,97 a	88,78
7,5	69,09 b	92,11 ab	101,67 a	87,63
10	98,97 ab	90,44 ab	104,22 a	97,88
12,5	89,31 ab	111,09 a	95,98 a	98,79
15	87,58 ab	118,99 a	88,95 a	98,51
20	119,43 a	108,87 a	90,88 a	106,39
F test	1,97 ‡	3,86 **	0,94 ns	-
DMS	50,31	45,36	35,05	-
C.V. %	36,78	34,97	27,20	-

Average values followed by same character in the column do not show difference as by Tukey test 5% probability. ns – not significant (p≥0,10); ‡ significant at 10% probability (0,01≤p<0,10); *- significant at 5% probability (0,01≤p<0,05); **- significant at 1% probability (p<0,01).
LSD – Least Significant Difference

The results presented on Table 5 indicated an increased production for all treatments except 7,5 Gy on the first event. The total production was highly influenced by application of gamma radiation in the seeds.

The "Threshold model", widely accepted as the dose-response curve of gamma radiation, does not seems to apply for low doses of radiation. In case of use of low doses of gamma radiation, as observed here, the "Hormesis model" is suitable to explain the germination and fruit development occurred.

Tabela 5. Total production of three harvests and sum of all three harvests.

Treatment Gy	Total production in grams			Total production of 3 harvests in grams	Relative total production in %
	14/08	13/09	11/10		
0	1714,06 ab	1494,17 c	3040,26 b	6248,49	100,00
2,5	1513,22 ab	3009,90 bc	4534,69 ab	9057,81	144,96
5	2162,09 ab	1679,84 c	4171,34 ab	8013,27	128,24
7,5	804,65 b	2690,33 bc	3739,54 ab	7234,52	115,78
10	2641,23 a	2662,77 bc	6321,30 a	11625,30	186,05
12,5	1466,57 ab	7100,02 a	2493,25 b	11059,84	177,00
15	1732,23 ab	6965,03 a	2492,60 b	11189,86	179,08
20	2387,54 a	5023,17 ab	2271,01 b	9681,72	154,94
F test	2,92 **	12,85 **	3,92 **	-	-
LSD	150,53	276,63	305,41	-	-
C.V. %	59,83	51,78	60,23	-	-

Average values followed by same character in the column do not show difference as by Tukey test 5% probability. ns – not significant ($p \geq 0,05$); *- significant at 5% probability ($0,01 \leq p < 0,05$); **- significant at 1% probability ($p < 0,01$).
LSD – Least Significant Difference

4.CONCLUSIONS

The use of low doses of gamma radiation has stimulated tomato seed germination, the number of green fruits and total number of harvested fruits.

The use of low doses of gamma radiation applied to the seeds has also stimulated the average fruit weight during the first two harvest events.

Total final tomato production was increased with the use of low doses of gamma radiation in the seeds with the dose of 10 Gy achieving the highest yield.

Considering the above mentioned results, the use of radiation might be recommended as a seed treatment procedure to stimulate germination and increase tomato productivity.

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